CONTEMPORARY PRACTICES FOR SUSTAINABLE LIBRARY AND INFORMATION SERVICES

A Festschrift in Honour of Professor Ahiaoma Ibegwam

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Chapter 13

Artificial Intelligence and Machine Learning in Academic Libraries in Contemporary Nigeria

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Abstract
Technology adoption has undoubtedly stimulated advancement in all facets of human endeavour. It has brought about ease, accuracy and speed in performing diverse tasks in many organisations and corporations worldwide. It is believed to have a great effect on the new world of work such as can be found in the library. Information and Communication Technology has so permeated the fabric of Library operations that concepts like Artificial Intelligence and Machine Learning are interoperable with library systems. In developed countries, Artificial intelligence technologies are now being used in libraries and information centres to achieve the organic integration of readers and libraries. This is a current reality because of extensive innovations in science and technology which has resulted in an explosion. Therefore, the rationale for the incorporation of modern technologies into the routine operations of the library hinges on user satisfaction. Regrettably though, the rampant budget cuts experienced by academic libraries in developing countries has made it near-impossible for them to acquire Artificial Intelligence technology. Moreover, poor electric power supply has contributed to this quandary. Unfortunately, despite the digital revolution, academic libraries in the developing nations are not at par with their contemporaries in the developed world. To attain this level of technological development via the acquisition and adoption of Ai systems in academic libraries in developing countries such as Nigeria, it is essential that adequate funding should be provided among others.

Keywords: *Artificial Intelligence, Machine Learning, Academic Libraries, Nigeria*

Introduction

Academic libraries in Nigeria are saddled with the responsibilities of providing information resources in all formats in order to meet the information needs and support the mission and vision of its parent institution. According to Folorunso and Urhiewhu (2016) an academic library is a warehouse of information resources, processed and accessible for research works and human resources development. In higher institutions of learning, the four major infrastructures are laboratories, equipment, teachers/classrooms and libraries

that contain rich and balanced information resources that can support teaching; learning and research work (Tiemo & Ateboh, 2016). Libraries are therefore the nerve centre of an educational institution and provide information to serve all patrons irrespective of their ages, political and ethical background, religion, sex, etc (Yusuf et al., 2022). The transition of information materials from book collections to audio-tape collections, video collections, databases, digitisation of information materials, library automation, and now the adoption of artificial intelligence in library operations. Vijayakumar & Vijan, as cited in Yusuf et.al (2022); implies that one of the motives of adopting AI technologies in academic libraries is to satisfy user needs.

Over the past few decades, Artificial intelligence (AI) and Machine Learning (ML) have become major catalysts of reshaping our world and the way we think, act and make decisions (Vysakh & Babu, 2020). Many leading organisations such as Google, IBM, Amazon, Netflix, Expedia and so on have adopted machine learning and artificial intelligence attributes to improve their products and services. Almost all major sectors like; health, education, weather, business, stock, agriculture, government and non-government agencies of different countries are also showing interest and using these technologies to simplify and neutralise workload, increase and speed up productivity, reduce human interaction and most importantly lead the digital-world in a smart and sophisticated way. Therefore artificial intelligence (AI) technologies have become globally recognised and adopted as indispensable tools for improving organisational efficiency and productivity. Suffice therefore to say that AI technologies have strongly influenced the world of work in the 21st century. In the library setting, the adoption of AI can improve library services and provide access to accurate information that can drive growth and development in this information age (Yusuf et al, 2022). Artificial intelligence technologies are now being used in libraries and information centres to achieve the organic integration of readers and libraries. With this, readers interact on the same platform, track and acquire the personalised needs and information of users so that users can access information accurately, and humanised services, at a reduced cost to rationally utilise library resources. Tella (2020) stressed that libraries in the developed countries have accepted and use AI technologies virtually in all spheres of life whereas those in developing countries are still struggling to find their feet. This study therefore intends to examine artificial intelligence and machine learning in academic libraries in contemporary Nigeria by looking at the concept of artificial intelligence, a brief history of artificial intelligence and machine learning, types of artificial intelligence methods adopted by academic libraries, benefits of artificial intelligence and machine learning, challenges of artificial intelligence and machine learning, prospects of artificial intelligence and machine learning, conclusion and recommendations.

Concept of Artificial Intelligence

Artificial Intelligence (AI) is defined as the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings. AI is also defined as, an Intelligent Entity Created By humans Capable of Performing Tasks intelligently without being explicitly instructed, capable of thinking and acting rationally

and humanly; therefore artificial intelligence is a set of algorithms that can produce results without having to be explicitly instructed to do so. Artificial Intelligence (AI) according to Nwakunor (2021), is the computer controlled robot that thinks intelligently like human beings. These robots are controlled electronically with the aid of the computer by mimicking the competences of the human mind. Artificial Intelligence keeps records and analyses every action being made by the user. As a result of innovation in science and technology, Artificial Intelligence is used in all facets of life for human development and comfort (Adejo & Misau 2021). Tredinnick (2017) described AI as a cluster of technologies, and various computing science approaches to make flexible rational decisions that align with unpredictable environmental conditions; however, this thread can be linked to process automation, the Internet of things, data processing, tangible robotic, conversational interactions and decision support. The intelligence demonstrated by machines is known as Artificial Intelligence. Artificial Intelligence has grown to be very popular in today's world. It is the simulation of natural intelligence in machines that are programmed to learn and mimic the actions of humans. These machines can learn with experience and perform human-like tasks. As technologies such as AI continue to grow, they will have a great impact on our quality of life. Naturally everyone today wants to connect with AI technology somehow, whether as an end-user or pursuing a career in Artificial Intelligence.

Artificial intelligence is the simulation of human intelligence processes by machines, especially computer systems. According to Benhamou and Janin (2018), AI involves a collection of technologies that enable machines to act with a very high level of intelligence similar to humans. Merriam-Webster English Dictionary (2018) stated that artificial intelligence is "a part of computer science that deals with giving the ability to machines to look as if they have natural human intelligence." Specific applications of AI include expert systems, natural language processing, speech recognition and machine vision. According to Omame and Alex-Nmecha (2020), the sound of the term artificial intelligence often conjures images of robots or computers that talk. Artificial intelligence is an aspect of computer science that focuses on how computers learn (Machine Learning), interpret information, vision: character recognition, picture analysis, 3D perception, and modelling of the function of the eye; furthermore, it encapsulates speech recognition, speech production, understanding and use of natural language (Natural Language Processing), and Expert System which continues to gain more attention. Furthermore, artificial intelligence is the programming and development of computers to perform human required-intelligence tasks, such as speech recognition, decision-making, visual perception, language translation, talking and emotional feelings (Irizarry-Nones, Palepu & Wallace, 2017).

Furthermore, Asemi and Asemi (2018) asserted that the field of artificial intelligence deals with the study and development of computer systems or machines that exhibit some forms of human intelligence, such as learning new concepts and tasks, reasoning and drawing useful conclusions about a specific task, natural language processing or perception and comprehension of visual scene among others. AI applies to different sciences; therefore, it can be deduced that it is more applicable in scientific databases and library systems in the

library and information science field. It also applies to behavioural science, social sciences, psychology, management, library science and information science. It is related to some of the systems that apply different forms of intelligence such as learner systems, inferior systems, systems with natural language understanding or natural language interpretation, systems with visual scene perception and systems that perform other types of feat that require human types of intelligence (Asefeh, Andrea & Mohsen, 2020).

Concept of Machine learning

Machine learning according to Ali (2020) is an application of artificial intelligence (AI) that provides systems with the ability to automatically learn and improve from experience without being explicitly programmed. Machine learning focuses on the development of computer programs that can access data and use it to learn for themselves. Machines are playing a vital role in the library collection of resources and user services. Robotics, Chatbot, Text Data Mining (TDM), Big Data and Pattern Recognition are examples of Machine Learning tools within AI.

Brief History of Artificial Intelligence

Artificial intelligence was first coined by an American scientist John McCarthy in 1956 at the Dartmouth Conference and was coined for the first time as an academic field. The "first artificial intelligence programme" named "Logic Theorist" was constructed by Allen Newell and Herbert A. Simon. This programme verified 38 of 52 mathematical theorems, as well as discovering new and more elegant proofs for several of them. The enthusiasm towards Artificial Intelligence grew rapidly after this year. In 1959 Arthur Samuel coined the term machine learning while he was working at IBM; while in 1963 John McCarthy started an Artificial Intelligence Lab at Stanford. Joseph Weizenbaum created the first ever chatbot named ELIZA in 1966. In 1972, the first humanoid robot was built in Japan named WABOT-1. The period of 1974 to 1980 is famously known as the first AI winter period. Many scientists could not pursue/continue their research to the best extent as they fell short of funding from the government and the interest towards AI gradually declined. In 1980, AI was back with a bang as Digital Equipment Corporations developed R1 the first successful commercial expert system officially ending the AI winter period; moreover in that same year, the first ever national conference of American Association of Artificial Intelligence was organised at Stanford University. From 1987 to 1993 with emerging computer technology and cheaper alternatives, many investors and the government stopped funding for AI research leading to the second AI Winter period; however in1997 a computer beats human as IBM's computer IBM Deep Blue defeated the then world chess champion, Gary Kasparov, and became the first computer/machine to beat a world chess champion. In 2002, the inception of vacuum cleaners made AI enter homes. In 2005, the American military started investing in autonomous robots such as Boston Dynamics' "Big Dog" and iRobot's "PackBot."

Furthermore in 2006, Companies like Facebook, Google, Twitter, Netflix started using AI. In 2008, Google made a breakthrough in speech recognition and introduced the speech recognition feature in the iPhone app. In 2011 Watson, an IBM computer, won Jeopardy

in 2011, a game show in which it had to solve complicated questions and riddles. Watson had demonstrated that it could comprehend plain language and solve complex problems fast; while in 2012, Andrew Ng, the Google Brain Deep Learning project's founder, fed 10 million YouTube videos into a neural network using deep learning algorithms. The neural network learnt to recognise a cat without being informed what a cat is, which marked the beginning of a new era in deep learning and neural networks. In 2014 Google made the first self-driving car which passed the driving test, in the same year, Amazon's Alexa was released. In 2016, Hanson Robotics created the first "robot citizen," Sophia, a humanoid robot capable of facial recognition, verbal conversation, and facial emotion; while the one that broke the camel's back was in 2020 during the early phases of the SARS-CoV-2 pandemic, Baidu made its LinearFold AI algorithm available to scientific and medical teams seeking to create a vaccine. The system could anticipate the virus's RNA sequence in just 27 seconds, which was 120 times faster than prior methods. As each day progresses, Artificial Intelligence is making rapid advancements in all fields. AI is no longer the future, it is the present (Great Learning Team, 2023).

Types of Artificial Intelligence

Different Artificial Intelligence entities are built for different purposes, and that's how they vary. AI can be classified based on Type 1 and Type 2 (based on functionalities). Flowing therefrom is a brief introduction to the first type.

1. Artificial Narrow Intelligence (ANI)
2. Artificial General Intelligence (AGI)
3. Artificial Super Intelligence (ASI)

Artificial Narrow Intelligence (ANI)

This is the most common form of AI that can be found in the market now. These Artificial Intelligence systems are designed to solve one single problem and would be able to execute a single task well. By definition, they have capabilities, like recommending a product for an e-commerce user or predicting the weather. This is the only kind of Artificial Intelligence that exists today. They come close to human functioning in specific contexts, and even surpass them in many instances, but only excel in controlled environments with limited parameters.

Artificial General Intelligence (AGI)

AGI is still a theoretical concept. It is defined as AI which has a human-level of cognitive function, across a wide variety of domains such as language processing, image processing, computational functioning and reasoning and so on. An AGI system would need to comprise thousands of Artificial Narrow Intelligence systems working in tandem, communicating with each other to mimic human reasoning. Even with the most advanced computing systems and infrastructures, such as Fujitsu's K or IBM's Watson, it has taken them 40 minutes to simulate a single second of neuronal activity. This speaks to both the immense complexity and interconnectedness of the human brain, and to the magnitude of the challenge of building an AGI with our current resources.

Artificial Super Intelligence (ASI)

This seems like an adventure into science-fiction territory here, but ASI is seen as the logical progression from AGI. An Artificial Super Intelligence (ASI) system would be able to surpass all human capabilities. This would include decision making, taking rational decisions, and even includes things like making better art and building emotional relationships. Once Artificial General Intelligence is achieved, AI systems would rapidly be able to improve their capabilities and advance into realms that we might not even have dreamed of. While the gap between AGI and ASI would be relatively narrow (some say as little as a nanosecond, because that's how fast Artificial Intelligence would learn) the long journey ahead of us towards AGI itself makes this seem like a concept that lies far into the future.

Type 2: Based on the functionality of AI-based systems, AI can be categorised into the following types:

1. Reactive Machines AI
2. Limited Memory AI
3. Theory of Mind AI
4. Self-aware AI

Reactive Machine AI

This type of AI includes machines that operate solely based on the present data, they have no memory and focus only on the current situation. Reactive AI machines cannot form inferences from the data to evaluate their future actions. They can perform a range of predefined tasks. An example of Reactive AI is the famous IBM Chess program that defeated the world champion, Garry Kasparov.

Limited Memory AI

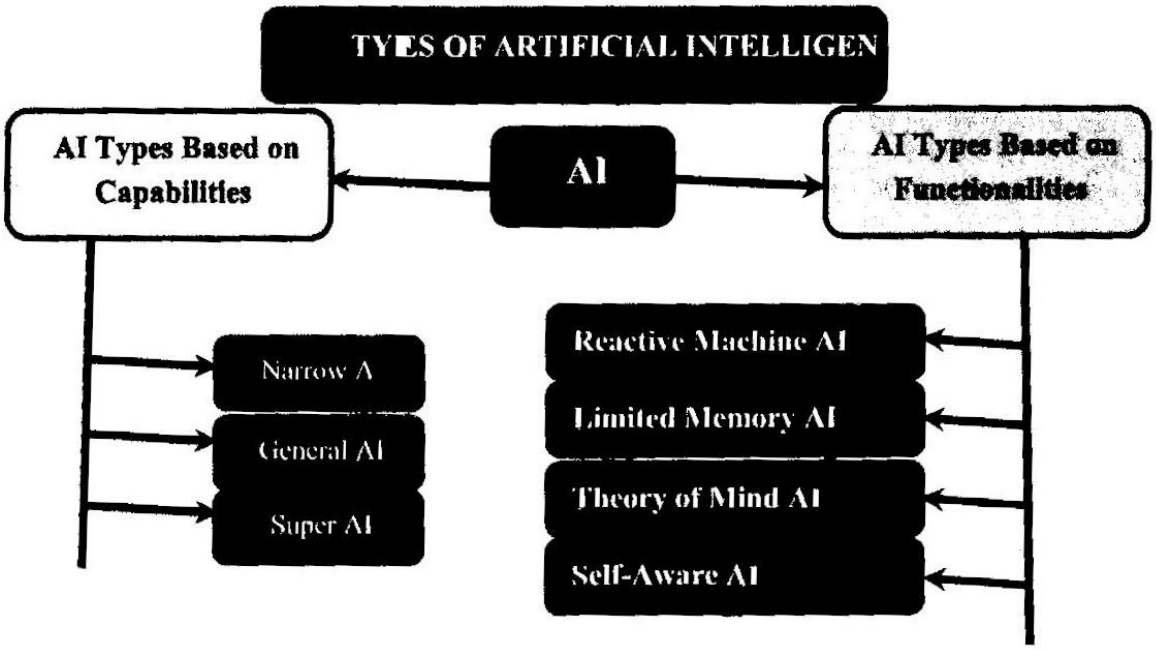
Limited Memory AI can make informed and improved decisions by studying the past data from its memory; such an AI has a short-lived or a temporary memory that can be used to store past experiences and hence evaluate future actions. Self-driving cars are Limited Memory AI that uses the data collected in the recent past to make immediate decisions. For example, self-driving cars use sensors to identify civilians crossing the road, steep roads, traffic signals and so on to make better driving decisions. This helps to prevent any future accidents.

Theory of Mind AI

The Theory of Mind AI is a more advanced type of Artificial Intelligence. This category of machines is speculated to play a major role in psychology. This type of AI will focus mainly on emotional intelligence so that human beliefs and thoughts can be better comprehended. The Theory of Mind AI has not yet been fully developed but rigorous research is happening in this area.

Self-Aware AI

Machines have their own consciousness and become self-aware in this stage. This type of AI is far-fetched given the present circumstances; however, in the future, achieving a stage of super intelligence might be possible. Geniuses like Elon Musk and Stephen Hawkings have consistently warned about the evolution of AI.



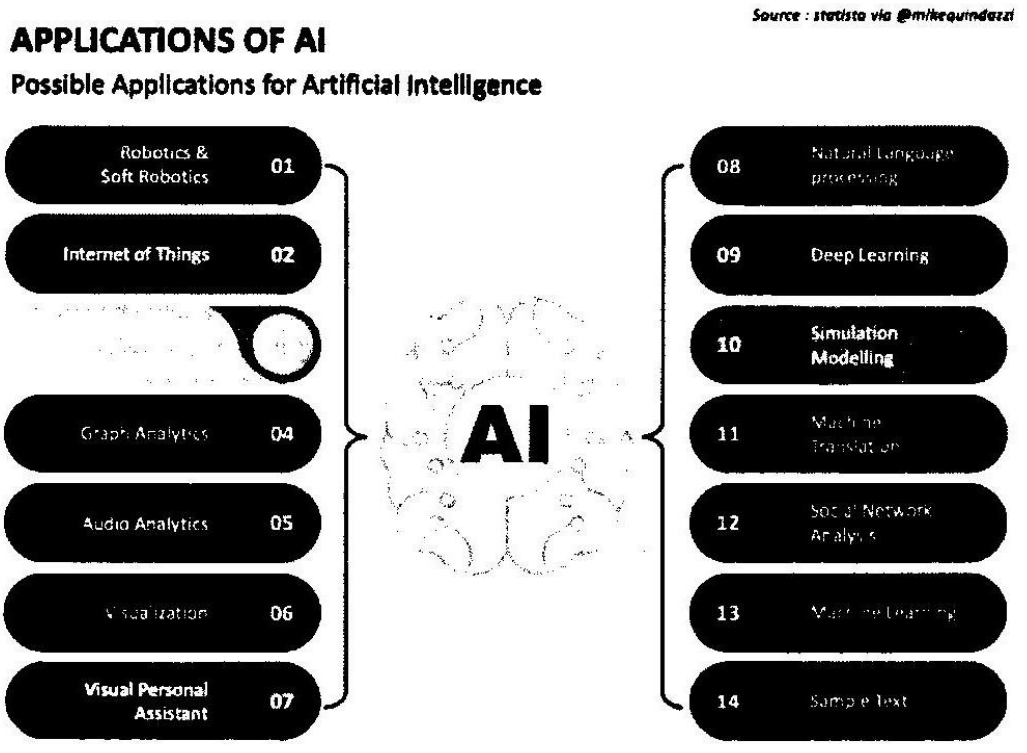
Graphical display of Types of Artificial Intelligence based on Capabilities and Functionalities
Source: Application of artificial intelligence

Machines and computers affect how we live and work. Top companies are continually rolling out revolutionary changes to how we interact with machine-learning technology. DeepMind Technologies, a British artificial intelligence company, was acquired by Google in 2014. The company created a Neural Turing Machine, allowing computers to mimic the human brain's finite memory. Google's driverless cars and Tesla's Autopilot features are the introductions of AI into the automotive sector. Elon Musk, CEO of Tesla Motors, has suggested via Twitter that Teslas will have the ability to predict the destination that their owners want to go via learning their pattern or behaviour via AI. Furthermore, Watson, a question-answering computer system developed by IBM, is designed for use in the medical field. Watson suggests various kinds of treatment for patients based on their medical history and this has proven to be very useful.

Some of the more common commercial business uses of AI are:

1. Banking Fraud Detection: From extensive data consisting of fraudulent and non-fraudulent transactions, the AI learns to predict if a new transaction is fraudulent or not.

2. Online Customer Support: AI is now automating most of the online customer support and voice messaging systems.
3. Virtual Assistants: Siri, Cortana, Alexa, and Google now use voice recognition to follow the user's commands. They collect information, interpret what is being asked, and supply the answer via fetched data. These virtual assistants gradually improve and personalise solutions based on user preferences.
4. Online shopping: Artificial intelligence is used in online shopping to provide personalised recommendations to users, based on their previous searches and purchases.
5. Digital personal assistants: Smartphones use AI to provide personalised services. AI assistants can answer questions and help users to organise their daily routines without a hassle.
6. Machine translations: AI-based language translation software provides translations, subtitling and language detection which can help users to understand other languages.
7. Cybersecurity: AI systems can help recognise and fight cyber-attacks based on recognising patterns and back tracking the attacks.
8. Artificial intelligence against Covid-19: In the case of Covid-19, AI has been used in identifying outbreaks, processing healthcare claims, and tracking the spread of the disease.



Application of Artificial Intelligence in Academic Libraries

The intensive pressure on librarians to provide high quality services to library users due to information explosion in our present society has led to incorporation of modern

technologies. Artificial Intelligence has found its way into the library as a chatbot that handles directional questions on library websites, overdue alerts, responses to simple informational requests and directs users to relevant resources in the library (Adejo & Misau, 2021). Artificial Intelligence is a collaborative robot that interacts with humans on the library floor and performs complex or repetitive tasks. Artificial Intelligence (AI) is a suitable attempt to replace human power with the machine. The adoption of AI in the library will influence connectivity of information technology and actively support information usage, ease clients' search and immediately address their needs. The impact of artificial intelligence and advanced computer technology on the nature of libraries' will be enormous and the quality of difference varies among experts (Vijayakumar & Sheshadri, 2019). Intelligent library automation systems rely on artificial intelligence technologies to provide knowledge-based services to library clientele and staff. Artificial intelligence in libraries should not be misconstrued with library automation; while the latter implies the degree of mechanisation of library operations, the former goes beyond just automating library activities, and intelligent rational systems that behave and act like librarians and require little or no human intervention. According to Sridevi and Shanmugan (2017), artificial intelligence is the modern technology used to manage the digital library. The ultimate promise of artificial intelligence is to develop computer systems or machines that think, behave and rival human intelligence, with significant implications in librarianship. According to Omame and Alex-Nmecha, (2020) Artificial intelligence in library and information services include but are not limited to:

Automatic cataloguing and classification using Optical Character Recognition (OCR)

Automatic translation of foreign language materials using Natural Language Processing (NLP)

Automatic indexing using Expert Systems

Retrieval of audiovisual materials Optical Character Recognition and Speech Recognition. Music and pictures in the library's collections can be called up as fast as printed records – a new dimension to knowledge storage and management.

Interactive bibliographic instruction using various media

Intelligent gateways to online sources,

User-structured information environment

Portable computer reader services for the handicapped

Intelligent Document Delivery Services (DDS)

Advantages of Artificial Intelligence in Libraries

Generally speaking, artificial intelligence is installed in machines or computers to reduce human casualties in wars, hazardous work environments, car accidents, plane crashes, fire explosions or disasters as a result of human error. Furthermore, artificial intelligence facilitates human work with greater speed, efficiency and effectiveness in work environments such as the library. According to Vijayakumar and Vijayan (2011), artificial intelligence and expert systems are used in classification, cataloguing and indexing of library materials via the use of optical character recognition and neural network, the system

is able to obtain the bibliographic records of books and classify them accordingly. According to Asemi and Asemi (2018), natural language processing can be used to reduce language barriers. For instance, one has to learn Chinese in order to study in China. The availability of Natural Language Processing systems in their libraries can assist the foreign students to translate and understand Chinese. Moreover, Natural Language Processing systems can also assist in searching for information in Multilingual databases. In addition, expertise is needed in the provision of qualitative service delivery in libraries, as such, artificial intelligence and expert systems will improve the performances of library services and reduce the rate of human errors and defects and can perform tasks faster than a human being can most likely (Shohana, 2016). Romero (2018) submitted that artificial intelligence could facilitate searching and retrieval of new media with greater efficiency and effectiveness by library patrons and introduce them to new material they may never have found otherwise. In addition to convenience and entertainment value, using artificial intelligence to suggest similar materials could also help library clientele who are carrying out research by searching the library database in an instant. Generally speaking, artificial intelligence systems can read to you, inform you, advise you, teach you, correct your mistakes, and patiently respond to your myriad of demands. Thus artificial intelligence holds great potential for library and information service.

The benefits of artificial intelligence in libraries can be summarised as follows:

1. According to Ex Libris (2019) which the authors agree with, artificial intelligence in libraries can make research more discoverable which can boost research productivity among faculty members,
2. Bridge in Time: Round the clock accessibility to information resources and services just in time.
3. Bridge in Space: The space occupied by piles of books, journals, bound newspapers and other information materials has been reduced by the introduction of digitisation, electronic copies and use of robotic cranes that store and retrieve books from a compact off-site storage location.
4. Maximisation of Efficiency: This refers to efficiency in library operations: selection and acquisition of materials, technical services, circulation services, references services, serial management etc.
5. Maximisation of effectiveness in the form of improved service delivery and elimination of human errors in library operations.
6. Minimisation of Effort: The effort expended by librarians in technical services, circulation services, references services, serial management among others, can be minimised by the use of artificial intelligence systems in libraries.
7. Enhanced and immersive user experience in library services delivery.

Disadvantages of Artificial Intelligence in academic Libraries

Although artificial intelligence is a promising innovative idea in the library system, it is not without disadvantages. Shohana (2016) outlined some of the disadvantages of artificial intelligence as follows:

1. Artificial intelligence systems have the ability to replace human jobs thereby increasing the unemployment rate in the society. This has been an issue of concern among librarians for decades. The fear is that intelligent machines with capabilities of shelving books, retrieving information, answering reference queries and attending to users have great potential of replacing librarians, leaving them unemployed. Jasrotia (2018) also opines that as intelligent machines in libraries can read digitised resources, analyse and offer customised insights, answers and services faster than librarians, the possibility of AI being a 'threat' to librarians but not to libraries does exist. This is probably why many librarians do not like the idea of artificial intelligence in libraries. Nevertheless, Guion (2019) argues that librarians would still be needed because machines with AI systems would still not be able to fully discern what a library user wants as sometimes search terms do not fully explain the need or even judge how well their outputs conforms to basic library principles of intellectual freedom, copyright and data privacy.
2. Artificial intelligence systems can malfunction and perform tasks they were not programmed to do. The fear, according to Ex Libris (2019), is the possibility of Artificial Intelligence systems in libraries propagating misinformation if the algorithms powering them becomes problematic.
3. Artificial intelligence systems can be misused leading to mass scale destruction.
4. Over dependence on artificial intelligence systems can make librarians forget the basic and fundamental processing involved in library operations such as cataloguing and classification, since a robot would be handling that.
5. Lack of the 'human touch'. Some users will prefer to interact with human beings directly and express their feelings rather than to a machine.
6. The potential of hacking which could lead to a compromise of user information

Challenges of Implementing Artificial Intelligence in Libraries

Artificial intelligence systems are generally not in operational use in most libraries today. The limitations to implementing artificial intelligence systems in libraries especially in developing countries include the following:

1. Lack of technical know-how to use and operate artificial intelligence systems among the library staff.
2. Lack of adequate funding to develop or procure artificial intelligence systems in libraries. Since the budgets for hardware and software are frequently tight, there is always a constraint to the type of system the library can purchase or develop.
3. High system development and maintenance cost of artificial intelligence systems in libraries.
4. Epileptic power supply to power artificial intelligence systems in libraries especially in developing countries.
5. Inherent complexities of expert/artificial intelligence systems' development.
6. Limited natural language capabilities.
7. Intelligent systems lack that common base of human knowledge, severely constraining the types of functions that they can perform.

8. Limited number of artificial intelligence experts among library automation vendors. The field of artificial intelligence is complex and thus, requires a specialised knowledge in that aspect far beyond the development of conventional automation systems.

Conclusion

As humans, we have always been fascinated by technological changes and fiction; Albeit, we live amidst the greatest advancements in our history. Artificial Intelligence has emerged to be the next big thing in the field of technology. Libraries and organisations across the world are coming up with breakthrough innovations in artificial intelligence and machine learning. Artificial intelligence is not only impacting the future of every industry and every human being but has also acted as the main driver of emerging technologies like big data, robotics and Internet of Things.

Academic libraries have an excellent opportunity to collaborate with other key stakeholders to advance the wider development of AI within their respective institutions. For example, they could initiate a conversation with institutes and/or departments who have established an AI hub. They could collaborate with computer science departments to co-sponsor activities which create greater awareness more broadly of AI, e.g. seminars and workshops. Academic libraries in order to take advantage of these emerging technologies have to learn to apply AI in the daily library routine such as technical services, reference services, circulation services, referral services, resource management and information retrieval/dissemination.

Recommendations

Considering the growth rate of Artificial Intelligence in academic libraries, the following recommendations are therefore, made by the researchers:

1. Trained and certified professionals should be invited to train and retrain library staff on the application and utilisation of AI
2. Within the LIS profession, academic libraries could work collaboratively to encourage LIS schools to update their curriculum to include more in-depth coverage of AI technologies.
3. Adequate funding for acquiring and maintaining AI equipment
4. Alternative power supply such as solar panel installation and inverter should be made available in libraries.

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